The Spectrum of Ritual

A Biogenetic Structural Analysis

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The Neurobiology of Ritual Trance

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> **It is a fundamental premise . . . that all functions of the body, mental and emotional as well as the more obvious "physical" functions, depend on alterations in the patterns of materials of which the body is built. Protoplasm, cells, tissues, organs and organisms represent patterns of materials which at other times, in other arrangements, are different things, both animate and inanimate. Mental and emotional phenomena are inconceivable in the absence of a neural substrate, and function without an alteration of substrate pattern is incomprehensible.**
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For many years ethnographers have returned from the field with intriguing reports of unusual behavior by participants in rituals. These reports, although far from agreement in their labeling, interpretation, or rigor of observation, point to the impact of patterned, repetitive acts on the human nervous system. The purpose of this chapter is to bring neurobiological data to bear on the observed phenomena, which I collectively term *ritual trance*. It is my

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aim to demonstrate that ritual trance, known by many names and manifested in numerous forms, arises from manipulation of universal neurophysiological structures of the human body, lies within the potential behavior of all normal human beings, and functions as a homeostatic mechanism for both individuals and groups.

Ritual trance may constitute a hitherto neglected cultural universal. Using Murdock's Ethnographic Atlas (1967), Bourguignon identifies institutionalized forms of "dissociation" in 437 societies, 89 percent of the 488 societies for which adequate ethnographic data are available (1972:418). On the basis of this evidence, one of Bourguignon's students, Goodman, asserts that "we are dealing with a capacity common to all men" (1972:70). Near-universality of these experiences suggests a human biological substrate or propensity (see chapter 1); this interpretation is confirmed by observable changes in motor behavior, speech patterns, and response to external stimuli in trance states reported both by laymen and by scientifically trained observers.

Previously, approaches termed "physiological and psychological" (Firth, 1969:x), "neurophysiological and biocybernetic" (Bourguignon, 1973:6), and "biopsychological" (Shack, 1972:xi) have been applied to the study of ritual trance, with varying degrees of insight, thoroughness, and success. Generally speaking, anthropologists have not equipped themselves to understand and apply perspectives from the biological and psychological sciences to ethnographic observations; the subjects of inquiry, theories, and methods of these disciplines do not readily coincide with traditional anthropological interests in culture or social structure. Instead, anthropologists usually elect either to confine their disquisitions of trance phenomena to social or cultural matters or to rely uncritically on the few findings of other scientists that directly treat ritual trance, incorporating these narrowly focused, and often ethnocentric, interpretations into their analyses.

One notable exception is recent work on ceremonial possession by Walker (1972), including chapters on pertinent research in neurophysiology and hypnosis. However, the bulk of Walker's emphasis is on experiments that demonstrate effects of repetitive stimuli on the brain. Although brain structures undeniably play an

important role in response to stimuli, other components of the nervous system are involved in acts that facilitate trance. For example, emetics stimulate the vagus nerve of the parasympathetic nervous system by inducing vomiting, and, as will be demonstrated later, the parasympathetic nervous system mediates responses in the viscera and in the striated muscles, as well as in the brain.[1]

The nervous system operates as a unit, encompassing all levels from the myotatic reflex (tonic contraction of the muscles in response to a stretching force) to higher cortical functions (for example, reason and foresight). Thus, to exclude from discussions of central nervous system (CNS) excitation either the parasympathetic or sympathetic nervous systems, both of which are subsystems of the autonomic nervous system (ANS), not only is arbitrary but also belies the integration of the nervous system necessary for maintenance of homeostasis. In brief, investigation of ritual trance cannot be restricted to brain behavior, because the organs of the body are homeostatically interconnected by the nervous system.

Particularly fertile for neurophysiological analysis of ritual trance and the effects of cultural practices that facilitate trance states is the concept of CNS tuning advanced by Gellhorn and his colleagues, as well as recent investigations of specialization in the two cerebral hemispheres conducted by several researchers in the neurosciences; these findings complement the results of several decades of anthropological research on the effects of interaction on human biological rhythms performed by Chapple. But a thorough outline of the physiological bases of human behavior, including ritual trance, would be exceedingly complex. Although specialists may fault this necessarily oversimplified account, data presented herein identify pertinent structures and provide explanations that both increase our current understanding of these phenomena and indicate domains requiring further investigation.

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[1] Those who wish to accord primacy to cortical activity of the brain need only to contemplate the effects of seasickness on both thought and motor behavior to see their arguments topple.

Ritual

Chapple speaks of rituals as fixed, precisely performed emotional-interaction forms (1970:292–295). From this perspective ritual behavior (by definition) consists of a sequence of repetitive acts. Although not all rituals evoke states of trance, rhythmic stimuli and fixed interaction tend to produce these states. As will be demonstrated, such factors entrain[2] biological rhythms, synchronizing these to respond to environmental exigencies. By eliminating, correcting, or avoiding dysphasias, entrainment enhances survival opportunities in all species (Chapple, 1970:29).

According to Chapple (1970), dysfunctional, disparate emotional states among members of a group—what he terms "emotional asynchronies"—cause disequilibria. Ordinary events, as well as life crises, disrupt usual, basal patterns, evoking dysphasic emotional responses. Repetitive, evocative sequences of behavior in the separation, transition, and reincorporation phases of rites of passage and rites of intensification establish similar emotional states in participants, restoring individual and group equilibria (Chapple and Coon, 1942; Chapple, 1970).

Moreover, from the perspective of communications theory (Leach, 1966; Birdwhistell, 1970), multifarious stimulations provide redundant messages and thereby reduce ambiguity. Exposure to manifold, intense, repetitive, emotion-evoking stimuli ensures uniformity of behavior in ritual participants. Further, attainment of ritual trance is both an inward and outward manifestation of desired emotional states. If emotional synchrony is the goal of actions in rituals, then exhibition of behaviors attainable only when one is experiencing the appropriate inner state overtly attests to the existence of such a state. Deeds, rather than words, which may constitute falsehoods as well as truth,[3] demonstrate the authenticity and magnitude of one's faith, control of supernatural forces, or contact with spirit worlds. Extraordinary behaviors, such as "speaking in tongues" (glossolalia), handling fire, behaving like a supernatural entity, or exhibiting unusual feats of endurance, so radically depart from and contrast to mundane experiences that they are ordinarily deemed sacred. In the absence of exact configurations of neural excitation—that is, degree of intensity of stimulation in specific loci, including autonomic and motor responses—these states are difficult to simulate.[4]

A broad variety of methods have been used to facilitate ritual trance. Lewis provides an overview:

> As is well known, trance states can be readily induced in most normal people by a wide range of stimuli, applied either separately or in combination. Time-honoured techniques include the use of alcoholic spirits, hypnotic suggestion, rapid overbreathing, the inhalation of smoke vapours, music and dancing, and the ingestion of such drugs as mescaline or lysergic acid and other psychotropic alkaloids. Even without these aids, much of the same effect can be produced, although usually in the nature of things more slowly, by such self-inflicted privations as fasting and ascetic contemplation (e.g., "transcendental meditation"). The inspirational effect of sensory deprivation, implied in the stereotyped mystical flight into the wilderness, has also been well-documented in recent laboratory experiments (1971:39).

Similar examples are provided by Wallace (1966), and all of these cultural practices suggest directions for productive neurobiological investigation. Goodman terms such techniques "driving behaviors," after the repetitive photic stimulations employed in electroencephalography to assess ictal (seizure) propensities in the rhythms of the cerebral cortex (1972:74). However, the list provided by Lewis obviously includes procedures that additionally excite other structures of the body. Systematic examination of driving behaviors categorized according to the structures they affect not only clarifies the role of these techniques in facilitating ritual trance but also demonstrates the extent to which knowledge of physiological function is applied by primitive people.

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[2] Entrainment refers to the process by which biological rhythms are synchronized by environmental stimuli. Chapple (1970:27) notes that three major synchronizers of circadian rhythms are light, temperature, and interaction. This presents an example of intraorganismic coordination discussed in chapter 1.

[3] However, in rituals certain utterances are simultaneously also actions. To illustrate, in the Iroquois Thanksgiving address, linguists identify performative segments, distinguished—semantically and morphologically as well as syntactically—by a shift in tense, wherein "words are transformed into actions." Typically, these Iroquoian performatives refer to the emotional states of thankfulness and gratitude (Foster, 1974).

[4] However, through simulation one may accomplish the same end by cultivating the capacities of the human body and thus facilitate learning by imitation of the appropriate behavioral configurations. Kildahl (1972), for example, describes the efforts of "guides" who assist people "seeking the Holy Spirit" to achieve glossolalia by manipulating their bodies and repeating strings of syllables.

Repetitive Stimuli and Brain Function

Several anthropologists have noted the significance of repetitive stimuli in ritual contexts. Needham asks "Why is noise that is produced by striking or shaking so widely used in order to communicate with the other world?" (1967:606) and notes that rhythmic sounds are identified with the transition phase of rites of passage (1967:613). Chapple sees musical rhythms as synchronizers entraining free-running body rhythms, commenting:

> Voodoo drums, the regular and driving rhythms of revivalistic ceremonies, the incessant beat of jazz or its teenage variants in rock and roll, must synchronize the rhythms of muscular activity centered in the brain and nervous system.
>
> Combined with the dance or with other rhythmic forms of synchronized mass movement—stamping the feet or clapping the hands over and over again—the sound and action of responding as the tempo speeds up clearly ''possess'' and control the participant. The external rhythm becomes the synchronizer to set the internal clocks of these fast rhythms (1970:38).

In their explanations Sturtevant (1968), Walker (1972), and Goodman (1972) report the laboratory investigations of Neher (1961; 1962) into the effects of repetitive photic and auditory stimuli on the electrocortical rhythms of the human brain.

In the research laboratory and as a medical diagnostic procedure electroencephalograph recordings from the scalps of individuals exposed to an intense flashing light approximating the frequency of the alpha, or resting, scanning brain rhythm (usually around ten cycles per second)[5] show increased wave amplitude. Light is a primary synchronizer of biological rhythms in all species (Luce, 1971:121; Chapple, 1970:27). Entrainment of brain rhythms via a rhythmic photic stimulus is quickly established and spreads throughout the brain, so that changes in the frequency at which the light is flashed alter the frequency of the brain waves (Neher, 1962:153).

In seizure-prone individuals photic stimulation evokes the characteristic spike waves presaging an epileptic episode, but even normal persons experience unusual sensations, strong emotions, pseudoperceptions, or myoclonic jerks. Auditory stimulation emanating from drums, producing innumerable frequencies and harmonics, elicits similar results, including temporal distortion (Neher, 1961; 1962). Comparable findings are reported by Walter and Walter (1949).

Drumming rhythms vary sufficiently in a given performance to evoke a response in most hearers so that individual differences in basal rhythms are potentially accommodated (Neher, 1962). In rituals, contrary to Neher's assessment, dancing may produce visual flicker effects due to shifts in ocular focus and the movement of dancers between an individual and a light source. Photic, and auditory, stimuli can spontaneously elicit seizures in susceptible individuals (Gastaut et al., 1949), so that the intense rhythmic photic and auditory stimulations generated by dancing to particular musical tempos and instruments appear to be sufficient synchronizers to effect entrainment of brain rhythms. Moreover, sustained motion also stimulates proprioceptors of the body and can result

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5. A great deal of mystique surrounds the alpha rhythm, but no special states of consciousness can be directly attributed to alpha production per se; rather, this brain wave frequency is usually associated with muscular relaxation, absence of visual scanning, or lack of ocular focus (Mulholland, 1972). (Furthermore, the localized specialization of brain structures engaged in processing specific types of information requires extreme precision in electroencephalographic recording—including exclusion of extraneous signals—and stipulation of the exact locus of particular wave frequencies is necessary for any significant interpretation of output.) In fact, rather than eliciting an exalted state of human consciousness, the alpha frequency not only is found in other mammals but also prosaically identifies cessation or ''diminution of information processing activity in a given area of the brain'' (Ornstein, 1972:199).

in dizziness with accompanying disturbances in vestibulary centers in the ear and baroreceptors in the carotid sinuses, both of which maintain equilibrium or balance; muscle tension or relaxation additionally affects emotional states (Gellhorn, 1967; 1968a; 1969). Further, as Neher observes (1962:156), in rituals not only does rhythmic stimulation often occur simultaneously in several sensory modes, but also adjunctive aids—such as fasting, breathing vapors, or hyperventilation—contribute to alterations in the biochemical environment of the body. All of these physiological manipulations, complexly combined in the context of a ritual, effectually generate stimulus bombardment of the human nervous system.

As Lewis observed, absence or blocking of stimuli, as in sensory deprivation or some meditation techniques, also perturbs the equilibrium of ordinary life situations (see also Naranjo and Ornstein, 1971). There seems to be a range of sensory stimulation, subject to cultural variation and individual differences, with upper and lower thresholds beyond which excitation in neural structures is altered and behavior of an organism is directly modified. In certain types of ritual trance, transcendental meditation, for example, a number of impinging stimuli are reduced or held constant. Ornstein (1972) asserts that the many forms of ritual trance, including meditation, as well as hyperkinetic behaviors, share characteristic evocation and predominance of the special capacities of the right cerebral hemisphere.

Recently, systematic inquiries into the capacities and functions of the cerebral hemispheres have expanded previous contributions made by Neher to the study of brain responses in ritual trance. In the last several years a number of specialists in the neurosciences, directing their attention to the neurobiologic foundations of human consciousness, have discovered a new domain for investigation in the right cerebral hemisphere, previously thought to be unspecialized and subordinate to the "dominant" left (in most right-handed and in the majority of left-handed individuals) hemisphere (Sperry, 1969; Bogen, 1969a, b, c; 1972; Galin and Ornstein, 1972; Morgan et al., 1971; Dimond, 1972; Gazzaniga, 1972; Levy, 1972; Kimura, 1973; Tunnell, 1973;

Nebes, 1974; see also Laughlin and d'Aquili, 1974:59ff). Ample evidence, carefully garnered from study of normal individuals, as well as of patients in whom the cerebral hemispheres have been surgically disconnected by transection of the intermediary neural structures (the corpus callosum and anterior commissure), documents the existence of two distinct modes of thought (Ornstein, 1972). Bogen summarizes the impact of these new findings: "Our present recognition is that the hemispheres are not as much 'major' or 'minor' as that they are complementary, and that each hemisphere is capable of thinking on its own, in its own way" (1972:194).

Briefly stated, in most human beings the left cerebral hemisphere functions in the production of speech, as well as in linear, analytic thought, and also assesses the duration of temporal units, processing information sequentially. In contrast, the specializations of the right hemisphere comprise spatial and tonal perception, recognition of patterns—including those constituting emotion and other states in the internal milieu—and holistic, synthetic thought, but linguistic capability is limited and the temporal capacity is believed absent. Specific acts involve complementary shifts between the functions of the two hemispheres (Bogen, 1969a, b; Dimond, 1972; Ornstein, 1972; Kimura, 1973).

In Ornstein's view (1972) the traditional concept of human consciousness as wholly rational, logical thought disrupted by interference from "lower" (phylogenetically earlier) structures controlling emotion is supplanted by a perspective in which there is alternation between the modes particular to each cerebral hemisphere; the left hemisphere is the domain of logic, the right hemisphere is that of emotion. Further, Ornstein argues that the exceptional feelings distinctive of ritual trance reside in the special abilities of the right hemisphere.

A shift from the time-binding, verbal, linear mode of thought into a timeless, oceanic gestalt, although it adds greater complexity to an already intricate model of human neurobiology, not only accords with Neher's research on auditory driving but also provides an explanation for subjective reports of temporal distortion and unusual sensations—often inexpressible experiences—presented by persons who have undergone ritual trance. Indeed, Leach notes that in "primitive and less primitive thinking," the concept of time is often rendered as "a repetition of repeated reversal, a sequence of oscillations between polar opposites," with the duration of rituals encompassing one sort of time period, "sacred," and differentiated from that of ordinary, "profane," time (1961:126:127). This interpretation is independently supported by Ornstein (1972), who describes many ritual practices that, in his estimation, evoke and place in preeminence right hemisphere functions and at the same time inhibit or hold constant the capacities of the left hemisphere. For example, in certain meditation techniques reduction of sensory inputs by means of repetition of a *mantram,* a mellifluous sound,[6] has the effect of monopolizing the verbal-logical activities of the left hemisphere, leaving the right hemisphere to function freely.[7] Conversely, response to the rhythms of chanting and singing, dancing, handclapping, and percussion instruments engages right-hemisphere capabilities, concomitantly evoking the "timeless" quality of the attendant experience (Ornstein, 1972).

Studies of hemispheric specialization, particularly investigations of linguistic function, illuminate another aspect of trance behavior. For example, among the characteristics of "altered states of consciousness," Ludwig (1968:77–83) names ineffability and memory disturbances, and Prince (1968:121) subsumes ritual trance phenomena under "psychomotor amnesiac states." Data are lacking that might indicate whether "amnesia" results from total absence of memory or from differences in language capacity between the two cerebral hemispheres. Prince, although he supports his classification system with evidence from electroencephalograph recordings of patients diagnosed as suffering psychomotor epilepsy or hysterical fugue states, as well as of sleepwalking subjects, does not identify recording procedures in the experiments he reports. This ommission is crucial because in some cases, for convenience, only unilateral recordings are taken.

Research on language function in the right hemisphere emphasized recognition or production of written words in literate subjects; these findings may not be comparable to results gained from nonliterate or preliterate subjects. Existing research does, however, suggest that, although not completely deficient in verbal ability, the right hemisphere appears to be better at recognition of nouns and adjectives than of verbs; available evidence is somewhat contradictory, owing to the differing laboratory procedures of the investigators (Nebes, 1974:5). However, if the capacity to conceptualize motion and process is absent in the right hemisphere, then the inabilty to describe trance experiences points to right-hemisphere dominance in such states. In this light, ineffability, as well as the "mystical" content of imageries used to explain trance phenomena, are products of interpretation within the verbal limits of a symbol system. Moreover, if the expressive qualities of art forms derive from right-hemisphere functions—as Ornstein and Bogen suggest—then these symbolic representations may reveal more about trance experiences than any necessarily constrained verbal descriptions.[8]

Other forms of nonverbal expression may be inferred from right cerebral hemisphere capacities and functions. Bogen reports right-hemisphere superiority in kinesthetic perception and the "awareness of human disability" (1969b:142, citing Luria, 1966:90), suggesting that this cerebral hemisphere is important in self-recognition of illness and in general perception of internal body states. Baldwin asserts that the majority of hallucinations (sensory pseudoperceptions) are the result of impaired right-hemisphere function; they occur under the effects of LSD-25, sleep deprivation, nutritional deprivation, metabolic dysfunction, and in body temperatures above 40° C or below 34° C (1970:3–8). Taken together, these conditions involve subcortical, as well as cortical, neural structures. Indeed, Fischer (1972) contends that hallucinations are the "language" by which the "mute" right hemisphere communicates ideas.

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[6] Although Ornstein describes *mantra* as meaning*less*, serious students of Hindu and Buddhist philosophies contend that *mantra* are meaning*ful* in mystical senses (Bharati, 1970:101ff). I am indebted to Oliver B. Lerch, Jr., for this emendation.

[7] This process seems analogous to Deikman's (1966) concept of "deautomatization."

[8] Ornstein (1972) also argues that interhemispheric communication results in creativity—under certain conditions syntheses that occur in the right hemisphere are sequentially analyzed and verbally expressed by the left. The implications of this idea for specialists in anthropology and in artificial intelligence are discussed by West (1974).

To extend the commentary, I submit that oceanic feelings, ineffability, or pseudoperceptions emanating from right-hemisphere preeminence, evoked by stimulation of subcortical and cortical centers, may also underlie concepts such as "mana," "faith," "power," and other labels for both personified and impersonal supernatural forces. This hypothesis, that these terms are attempts to verbalize about extraordinary sensations experienced in ritual trance, could be systematically investigated by ethnoscientists. Similarly, glossolalia, often comprising rhythmic patterns of meaningless sounds and stereotyped utterances, also merits examination as a behavior that predominantly emanates from the right cerebral hemisphere;[9] existing laboratory studies, such as Palmer's (1966), are inconclusive because of the small sample size. Empirical investigation should resolve the question of whether glossolalia appears only in trance, as Goodman (1972) contends, or is produced outside trance states, as Samarin (1972) argues.

Ornstein's assertions about the significance of right-hemisphere capabilities in trance phenomena might have been anticipated by a little-noticed result of Neher's experiments. In auditory driving, "a rather surprising finding was predominantly unilateral response in the right hemisphere of three subjects . . . one possible explanation is cerebral dominance (all subjects were right-handed)" (1962:449). Although in their comparison of spatial with verbal performance Galin and Ornstein conclude that the alpha, or resting, frequency preponderates in the hemisphere less involved in a task (1972:200), Morgan et al. (1971) observe that right-hemisphere activity is usually characterized by the alpha frequency and that tasks specific to that hemisphere only proportionately reduce alpha output. Neher's work strongly suggests that

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[9] Support for this observation is found in the earliest discussions of specializations of the cerebral hemispheres; in 1874 Hughlings Jackson argued that activity in the right cerebral hemisphere is the source of emotive and "automatic" speech (Benton, 1972:228). For a comprehensive treatment of the phylogenesis of human speech, see Count (1973); a review of neurophysiological contributions to linguistics is in Dingwall and Whitaker (1974).

one significant effect of auditory driving is enhancement of the alpha rhythm, especially in the right hemisphere, with consequent entrainment of cortical rhythms at that frequency.

However, reports of fairly continuous alpha frequencies in the right hemisphere may reflect culturally determined inhibition; laboratory subjects in these experiments are almost invariably white, male, middle-class college students from a cultural background emphasizing sequential verbal-logical reason rather than holistic synthetic perceptions. Although laboratory investigation has scarcely broached the topic, Ornstein (1972), analyzing ethnographic accounts of ritual trance, suggests that hemisphere alternation may be culturally influenced, and Bogen (1972:50), reporting preliminary findings from tests administered to Hopi Indians and to blacks, considers that "hemisphericity," "a tendency to rely more on one hemisphere than the other," may be culturally determined. This hypothesis cannot be evaluated until persons from a variety of cultural backgrounds are the subjects of research on functional hemisphere alternation, as Bogen (1972:51) freely admits.[10]

Another possible interpretation is that generally in the human species the right hemisphere has characteristics, including electrocortical activity, dramatically different from those of the left hemisphere. In contradiction Kinsbourne (1973) questions the validity of assertions that unusual, exalted, or mystical states of consciousness are the result of (temporary) right-hemisphere dominance, basing his objections on the total absence of such states in the behaviors and subjective reports of patients who have undergone surgical transection of the corpus callosum. However, these criticisms disregard several weighty factors. First, the patients are invariably residents of a society unusually distrustful of any state of consciousness that departs from a normative central tendency (see Wallace, 1959). Second, and correlatively, ritual trance experiences, insofar as they are institutionalized, are both explained and supported by intricate shared belief systems (*Ibid.*). Third, although the "split-brain" subjects provide singular opportunities for study of differences in capacity and function between the two cerebral hemispheres, their unique clinical status precludes direct and uniform behavioral comparison with other individuals. Fourth, and finally, overemphasis on the cerebral cortex in discussions of trance states omits from consideration the impact of multifarious stimuli on subcortical centers. If my conclusions are correct, driving behaviors during rituals, with their manifold excitement of numerous neural structures, subcortical as well as cortical, evoke greater accentuation of right-hemisphere activity than usually prevails. However, to examine comprehensively the pertinent neurobiological factors in ritual trance—and to avoid Cartesian notions of mind-body distinctions—the roles of the emotions and body rhythms in these states must also be examined.

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[10] Certainly, despite numerous cross-cultural studies designed to identify cognitive capacities and processes (for example, see Price-Williams, 1970), the tests, methods, and assumptions of these experiments remain open to question (Cole and Scribner, 1974). The concept of hemisphericity may enable both anthropologists and psychologists to sharpen the focus of their research on cognitive processes and to clarify issues of cognitive capacities. Bogen intimates that hemisphericity may bias the outcome of intelligence tests (1972:51), and the same tendency possibly accounts for assertions that primitive thought qualitatively differs from that of civilized peoples (for example, Levy-Bruhl's concept of "prelogical mentality").

Emotions and Biological Rhythms

As I have shown, in rituals the entire body, not merely the brain, receives repetitive stimulation. However, alteration in biological rhythms, or, more properly, entrainment, also occurs through interaction (Chapple, 1970:27). Participants in rituals are additionally exposed to the precisely performed acts of their fellow participants, as well as to the symbolic meaning of these acts. The effects of these interactions and of symbols on the nervous system are examined in the following discussion.

Both symbols and behavior derive from neurophysiological states and are accompanied, if not underlain, by inextricable emotional configurations. For example, Chapple asserts that symbols are "cultural shapings" of "neurophysical events" (1970:60) and that "coincident changes in physiological states on which fixed action patterns are based are to be called 'emotional reactions' " (1970:59; also, see Count, 1973, for a discussion of the neurobiological bases of the symbolic process). Further, he assumes that adaptive behavior is not simply confined to the "overt, observable changes in the skeletal-muscle activity," but, contrary to popular usage, includes "internal biochemical and physiological states" which mediate observable behavior (*Ibid.*). Observations similar to Chapple's are enunciated by Gray (1973), a psychologist employing a general systems approach. To summarize, symbols and behavior both result from excitation in neurophysiological structures and are associated with emotional states. Consequently, while attempts to separate one sector of an integrated neurobiological system, for other than heuristic purposes, are common, they are misleading distortions.

Hence, although the discussion now turns to the ANS, the neural subsystem that largely controls emotions and vegetative functions, we are examining only one part of a complex, interactive whole. Moreover, in spite of the fact that the ANS has been relegated to subsidiary status in conventional assessments of nervous system organization and operation, recent research in the neurosciences has revealed that this system is not completely "automatic" in its functions, that modifications in excitation in the system can be achieved through voluntary efforts—although the exact mechanisms by which these changes are effected are as yet unknown—and that the system plays an integral role in states of ritual trance.

As the major system maintaining homeostasis in the internal milieu, the ANS rapidly responds to changes in stimuli, both intrasomatic and extrasomatic, by appropriate excitations in the sympathetic or parasympathetic (sub)systems. These two neural structures are not independent; rather, with few exceptions organs are reciprocally innervated by both. Although qualitatively different in structure, stimulation of one subsystem dampens or inhibits functioning of the other.

Anatomical and neurochemical differences account for the distinct functions particular to each. Characterized by internal connectedness, the entire sympathetic nervous system (SNS) can be excited by stimulation of only a few nerves. Moreover, intense sympathetic response is synergistic, for neural stimulation in this system in turn triggers the release of adrenal hormones, as well as the neurohumors epinephrine and norepinephrine. Manifesting less internal connectedness, the parasympathetic nervous system, (PNS), releasing acetylcholine and serotonin, reacts *in toto* only in response to relatively simultaneous stimulation of its components (Leukel, 1972). Among other inputs, cold and fear excite the sympathetic system, while sweatbaths, emetics, and purgatives excite the parasympathetic system.

Up to a specific threshold, stimulation of the PNS generally results in more pleasurable states such as sleep, digestion, grooming, and relaxation, although intense stimulation results in discomforts such as frequent urination, fainting, voiding of the bowel, peptic ulcers, and other visceral disorders. Alert wakefulness is largely mediated by the SNS; fear and anger involve greater sympathetic excitation. Cannon, a pioneer of modern neurophysiology, described intense sympathetic response in terms of preparation for emergency situations (1929). In "fight or flight" contexts some arteries relax while others contract, shunting blood from the viscera to the somatic (skeletal) muscles. Blood pressure and heart rate rise, respiration increases, digestive activity ceases, and body cooling is achieved via increased perspiration. In short, the SNS mobilizes an organism by simultaneously arming the muscle structures and halting or reducing activity in organs not immediately necessary for escape or combat.

Continuous mobilization is dysfunctional; therefore parasympathetic compensation or rebound often follows and inhibits sympathetic reactivity, resulting in slowed respiration and heart rate, as well as diversion of blood to the viscera from the striated muscles, enabling restorative rest and renewal of energy—action of significant biological survival value.

A dynamic equilibrium between sympathetic and parasympathetic arousal usually prevails (Pribram, 1967:6); as one subsystem of the ANS is stimulated, excitation in the other, inhibiting, system is concomitantly evoked. Leukel writes: "A balance between SNS and PNS arousal is, therefore, always present, a balance that depends on individual differences in ANS sensitivity and on the current stimulus situation" (1972:91). With regard to individual differences, each person has a central tendency, termed "automatic balance," toward oscillation in autonomic function that potentially affects emotional characteristics.

As a result of longitudinal research, Wenger and Callen (1972) have identified five configurations or patterns of functional automatic factors in American subjects. Global application of these findings, based on examination of fourteen neurobiological variables, is only suggestive, for systematic cross-cultural studies are lacking, but the presence of five types of autonomic balance in a heterogeneous population raises questions about the number of patterns that might be found in more homogeneous social groups. The existence of several types of autonomic balance may alone explain the variety of techniques to facilitate trance found among the world's cultures, and individuals with anomalous autonomic balance may also provide an explanation for the failure of some persons to achieve trance states by employing the techniques used in rituals of their society. However, in the absence of definitive cross-cultural research (Kugelmass, 1972), and also because the variables used to discern autonomic balance are at best measures of central tendencies (Wenger and Cullen, 1972:567), at this time the foregoing observations are both speculative and indicative of the need for further investigation of this topic.

Although one might expect that a large repertoire of physiological states is necessary to account for the vast array of emotional nuances that individuals experience—and that artists in all media celebrate—empirical evidence contradicts this notion. Cannon (1929), for example, suggested that only a few basic states underlie the entire range of human experience, and more recently his work has been supported, although refined, by that of Orne and Scheibe (1964), Schacter and Singer (1962), and Johnson (1970). Moreover, autonomic reactions do not appear to be essential to the experience of emotion in adults, for paraplegics who cannot perceive visceral sensations still have emotional feelings (Leukel, 1972:366), and the autonomic effects of neurohumors such as epinephrine do not invariably result in predictable emotional responses unless the individual associates the experience with particular symbolic content (Schacter and Singer, 1962). Discussing the available evidence, Leukel concludes: "Although autonomic reactions seem *unnecessary* to emotional experience and behavior, they *can* initiate both, depending on how the subject interprets them" (1972:366). Cortical and subcortical centers controlling autonomic responses appear to become conditioned to react to emotional stimuli, and once learning has occurred, autonomic fluctuations are no longer essential to emotional experience. This may explain the onset of trance in response to only a single cue, as reported by Goodman (1972:85), as well as the observation that novices seem to be less able to control their behavior than experienced trancers (Lee, 1968:41–42; Walker, 1972:31; Katz, 1973:144–145).

Control of the PNS, which stimulates the pancreas to secrete insulin, originates in the anterior and central hypothalmus, and control of the SNS, which stimulates adrenal hormones, in the posterior and lateral hypothalmus. Internal conditions of brain tissue are affected by edema or dehydration, blood sugar level, and salinity, as well as amount of blood available to brain tissue. Decrease in cortical excitability and control over subcortical centers, which is important to facilitation of ritual trance, can be brought about by various agents—fatigue, insulin shock, hypoglycemia, compensated acidosis, and hypoxia are a few examples (Cohen, 1967)—directly or indirectly via driving behaviors.

Central Nervous System Tuning: The Function of Ritual

Autonomic or vegetative excitation does not occur independent of other neurobiologic systems. Indeed, among other structures each subsystem of the ANS is integrated with the brain and the skeletal muscles, and generally only under special circumstances (in laboratory experiments or under pathological conditions) are these somatic responses separable from autonomic function (Lacey, 1967). Moreover, stimulation of any segment of the nervous system evokes a response in the total, integrated system (Lacey and Lacey, 1970:205). With the model provided by Hess (1925), which emphasizes the interconnectedness and inseparability of these structures, it is appropriate to speak of autonomic-somatic integration in the ergotropic and trophotropic systems. The names of these two systems reflect the oscillating needs of an organism, inexorably shifting from energy-expending behavior to energy-conserving behavior.

Ergotropic response consists of augmented sympathetic discharges, increased muscle tonus, and excitation in the cerebral cortex manifested as "desynchronized" resting rhythms; the *trophotropic* pattern includes heightened parasympathetic discharges, relaxed skeletal muscles, and synchronized cortical rhythms (Gellhorn and Kiely, 1972). Kiely (1974:2) points to an interconnected "tripartite hub"—the limbic system, hypothalmus, and reticular formation of the paleocortex are its members—as comprising the mechanism that integrates purposive, foresighted behavior in man by mediating subcortical responses in the ergotropic and trophotropic systems. In his review of neurophysiological mechanisms, Kiely presents a table summarizing the effects of stimulation in each system; a modified version is provided in Table 4.1.

Fundamental to human perception is the ergotropic orienting reflex or "what-is-it?" response, which, as Sokolov (1963) indicates, involves complex body reaction, including muscular movements (turning toward the stimulus and focusing the eyes), autonomic changes (heart rate, circulation pattern, pupillary dilation), and shifts in cortical activity (from resting rhythms to desynchronized differentials in wave frequency and amplitude). Coordination of cultural and idiosyncratic patterns, which identify certain stimuli as appropriate for attention and others as superfluous, ensures that only a small proportion of the "deluge of raw information" from external and internal environments reaches the threshold of response, attesting to the brain's effectiveness as a filter of input (Smith, 1972:335). Habituation, attenuation of the orienting reflex that results when stimuli cease to be novel, is a product of trophotropic reactivity (Gellhorn and Kiely, 1972:401).

Table 4.1* Some Effects of Stimulation of the Ergotropic and Trophotropic Systems

Stimulation of the Ergotropic System	*Stimulation of the Trophotropic System*
Autonomic Effects	
Augmented Sympathetic Discharges	*Augmented Parasympathetic Discharges*
Increased heart rate, blood pressure, sweat secretion; pupillary dilation; inhibition of G.I. motor and secretory function	Reduction in heart rate, blood pressure, sweat secretion; pupillary constriction; increased G.I. motor and secretory functions
Somatic Effects	
Desynchrony of EEG, increased skeletal muscle tone, increased secretion of catabolic hormones: epinephrine, norepinephrine, cortisol, thyroxine, growth hormone, ADH, aldosterone	Synchrony of EEG, loss of skeletal muscle tone, blocking of shivering response, increased secretion of insulin, estrogens, androgens
Behavioral Effects	
Arousal, heightened activity, and emotional responsiveness	Inactivity, drowsiness, and sleep

*After Kiely (1974).

Hence, a shifting ergotropic-trophotropic equilibrium characterizes processing of intrasomatic and extrasomatic stimuli. Furthermore, although ergotropic excitation lowers thresholds of perception if, for example, pain or loud, fast music is sustained, trophotropic rebound results (Oswald, 1959); the seeming paradox can be attributed to tuning and reversal in the CNS.

A consideration of tuning and reversal phenomena is vital to comprehension of the nature and subsequent effects of ritual trance. According to Gellhorn and his colleagues most life situations, whether novel or habitual, have their effects on the internal milieu and contribute to a condition termed *tuning* (Gellhorn and Loofbourrow, 1963; Gellhorn, 1968b; 1969; Gellhorn and Kiely, 1973) "which refers . . . to the sensitization or facilitation of particular centers" (Gellhorn and Loofbourrow, 1963:91). Tuning may be accomplished by direct stimulation of either the sympathetic or parasympathetic system, use of drugs that activate or block one or the other system, or mental activity. Driving behaviors employed to facilitate ritual trance are actually elaborate methods of tuning the CNS.

Three stages of tuning are recognized (Gellhorn, 1970; Gellhorn and Kiely, 1973). In the first stage, response in one system increases while at the same time reactivity in the other system decreases. Augmented reactivity of the sensitized system continues; in the second stage of tuning, reached after stimuli exceed a threshold, not only is inhibition of the nonsensitized system complete, but also stimuli that usually elicit a response in the nonsensitized system instead evoke a response in the sensitized system. Behaviors resulting from this second stage of tuning are termed *reversal phenomena*. If stimulation continues, increased sensitization in this second stage can lead to a third, wherein reciprocal relationships fail and simultaneous discharges result (Gellhorn, 1970; Gellhorn and Kiely, 1973). The third stage of mixed discharges prevails as a product of chronic or intense excitation, as in prolonged or excessive stress (see chapters 5 and 9), and as characteristic of normal physiological states such as orgasm (Beltrami, 1973) and rapid eye movement (REM), or paradoxical, sleep; learned behaviors, including Zen and Yogic meditation and ecstasy states (Gellhorn and Kiely, 1972); and pathological states such as experimental and clinical neuroses, psychosomatic disorders, and psychoses (Gellhorn and Kiely, 1972).

These states are similar because of the shared occurrence of mixed discharges, although the source and degree of excitement in particular centers vary from one state to another, as do individuals' resultant symbolic interpretations. Superficial resemblances have engendered much confused but needless debate about correspondences between trance and sleep, trance and sexual activity, and trance and various pathological conditions (Beltrami, 1973). If each of these states is studied from a neurobiological perspective, as Walker (1972) urges in the case of trance, then the confusion can be resolved. It is, however, presently impossible to count the states of consciousness potentially available in human neurophysiology. For heuristic purposes Bourguignon's (1973) differentiation of "trance" from "possession trance" and Goodman's (1972) polar types, "hypoarousal and hyperarousal," constitute gross trial approximations and are misleading because in the former case the categories are based on cultural distinctions (that is, content, rather than structure) and in the latter are derived solely from observations of motor behavior. A synthesis combining Fischer's (1972) iconic model and Gaarder's (1971a, b) multivariate homeostatic control system would yield a more nearly comprehensive and realistic representation of the complex dynamics involved in human consciousness.

To date no laboratory research has specifically examined ritual trance requiring movement, such as dancing, although strategies for dealing with the problem have been proposed (Prince, 1968). Hence, evidence that ritual trance involves shifts in hemisphere dominance and trophotropic-ergotropic balance is extrapolated from neurobiological analyses of Yogic and Zen meditation and ecstasy, rather than from direct inquiry. Ornstein (1972) subsumes Zen and Yogic practices, as well as ritual trance including more active motor behavior, under a general rubric called "esoteric traditions," but in his view excitation of the right cerebral hemisphere is the fundamental basis for all of these behaviors. However, in the analysis of Gellhorn and Kiely (1972:403), who have devoted extensive research to the effects of tuning on the nervous system in both lower animals and man, meditation constitutes a shift in balance in the direction of trophotropic dominance with some degree of ergotropic excitation,[11] combining relaxation of the skeletal muscles with cortical alertness, while in ecstasy both relaxation and mental activity are further heightened. In these states learning has occurred in the nervous system (*Ibid.*).

Certain types of mixed discharges are therapeutic. Few neuroscientists would dispute the necessity of REM sleep for continued health, and Gellhorn and Kiely (1972) join Wallace and Benson (1971) in encouraging meditation practices as valuable in release from stressors. With regard to ritual trance, among anthropologists Walker (1972) most patently eschews notions of pathology and, instead, details the integrative and salutary benefits of ceremonial possession.

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[11] Wallace and Benson (1971:131) view transcendental meditation as the hypometabolic antithesis of the "defense-alarm reaction" ("fight or flight response"); in sum, in their analysis this process is wholly trophotropic.

Keeping in mind that trophotropic response refers to anabolic processes,[12] techniques to facilitate ritual trance generally employ trophotropic tuning, directly or indirectly via rebound to provide means to allay stress and to restore homeostatic functioning adaptively. Stiff, jerky limb and trunk movements (pseudocerebrate rigidity) and facial contortions, as well as twitches, all involve increased muscle tonus and are aspects of ergotropic activation, which, if intensified or sustained, can result in trophotropic rebound. Among other consequences, trophotropic tuning produces increased sensitivity to hyperventilation (Gellhorn and Loofbourrow, 1963:332), and hence chanting and singing augment trophotropic responses in this regard, in addition to providing repetitive proprioceptive and exteroceptive stimulation. Trophotropic tuning also reduces sensitivity to pain, which explains the ability of individuals to withstand adjudicative "autonomic ordeals" such as those described by Roberts (1967:170),[13] with response probably altered in the hypothalamus (Gellhorn and Loofbourrow, 1963:291).

Reversal phenomena appear to account for the seemingly paradoxical responses to temperature extremes reported by observers of certain ritual trances. For example, cold may be experienced as warmth and heat experienced as cold (Jesuit Relations, 17:175–79; 21:153). Reversal phenomena may also underlie "rites of reversal" analyzed by Gluckman (1965) and Norbeck (1967), among others. Taken together, prosaic behaviors and rites of reversal seem to demarcate the extreme boundaries of oscillations in temporal, social, and biological rhythms in human experience.[14]

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[12] An anabolic process is one of constructive metabolism, as opposed to catabolic, or destructive, metabolism.

[13] According to Roberts, "autonomic ordeals" are those instances "in which the judgment of success or failure, guilt or innocence, is dependent upon involuntary physiological responses such as scalding or blistering of the person or persons tested in the course of 'trials' or 'decision-making processes.' " Among these responses he includes "bleeding, burning, scalding, vomiting, floating . . ." (1967:170).

[14] Leach (1961) discusses several ways in which rites of reversal exhibit temporal and social oscillations.

Ritualized reversals, on close scrutiny, often do not seem to be true opposition (nor, for that matter, do binarily opposed categories; see Laughlin and d'Aquili, 1974:105; also chapter 5). Besides innate biological limits' prohibiting exact inversions, the periods of license in which reversals occur are more correctly described as temporal intervals during which certain unusual acts are permitted and encouraged, rather than as explicit, consistent transpositions of biocultural behaviors. Moreover, it seems likely that emotions evoked by these exceptional and ordinarily forbidden behaviors resemble exhilaration accompanying risk taking and thus entail mixed trophotropic-ergotropic discharges. Reversals can be viewed as experienced behavior patterns that wrench individuals or groups away from prior neurobiologic, as well as social, equilibria, instituting qualitatively different patterns in their stead.

Alert attention to detail is required for perfect execution of rituals, and thus performance engenders a certain degree of ergotropic activation. In addition, attention to detail in contexts requiring behavior explicitly contrary to routine patterns, whether in opposition to ordinary actions or to behaviors essential in other types of ritual, further heightens awareness by interrupting the trophotropic responses that prevail in habitual acts. For the novice, such external and internal stimulations are necessary for experiencing requisite emotions and manifesting socially approved behaviors appropriate to a specific ritual; for experienced participants, who have internalized the essential configurations of behavior, evoked responses may appear less significant but are, nevertheless, indispensable for establishing the proper setting for the ritual.

Turner's (1969) concept of *communitas* hints at a perception of shared emotional states among persons having presently or historically, individually or collectively, experienced equivalent conditions by common response mediated through human neurobiological structures. Ambivalence, created by oscillation between opposing emotional states, characterizes these "liminal" states wherein *communitas* prevails. Moreover, whether in the transitional phase of rites or in institutionalized deviant social roles, the liminal individual is simultaneously a part of and not a part of the ongoing social order; in like fashion alternation of categories of time, sacred and profane, constitutes the temporal pattern of a particular culture—neither category of time is less important or "real," for one cannot exist without contraposition of the other. Implicit in liminality is a recognition of contrast between part-whole (or figure-ground) perception of individual and collective experiences. This schizoid state is the condition of man, for acknowledgment that both alternatives exist is necessary so that individuals or groups may deliberately shift from one mode to the other; people return to the mundane world from the sacred and journey from their ordinary plane of existence to mystical realms.

Embedded in rites of passage (and rites of intensification) is the deliberate goal of change in neurophysiological functioning. In Chapple's words: "It seems quite evident, but little studied, that the rites have evolved, in part at least, as structured means through which equilibrium, in all its complex emotional-interactional patterns, is reestablished. In so doing, they discharge the emotional tensions which the sympathetic nervous system has built up" (1970:317). Gellhorn's discussion of the neurobiological processes operant in abreaction provides the insight that ritual trance is a form of catharsis. Apart from these rites, mixed neural discharges, but in different loci, appear to underlie psychosomatic disorders, including folk illnesses. Examples of this are magical fright as described by Gillin (1948), and the therapies employed by native curers and psychotherapists alike. This interpretation is in no sense contradictory; both disorder and treatment are symbolic expressions of the properties and relationships of human anatomical structures. Furthermore, neurobiological analyses of therapeutic techniques illuminate the disorders that are treated, as well as the dynamics of ritual trance.

Abreaction is probably the best known of the therapeutic procedures that manipulate neurobiological structures. The mechanism is described as "a process of reviving the memory of a repressed unpleasant experience and expressing in speech and actions the emotions related to it, thereby relieving the personality of its influence" (Gellhorn and Loofbourrow, 1963:297). The techniques for this therapy were developed to alleviate effects of battle fatigue or emotional shock; barbiturate or nitrous oxide is administered to patients who are then encouraged to relive a traumatic event under conditions of altered cortical functioning. Gellhorn's interpretation suggests that intense emotional excitement followed by exhaustion are at work in this form of therapy (*Ibid.*) Sargant (1957) compares the resultant condition to Pavlov's concept of "transmarginal inhibition," whereby prior conditioned reflexes are lost or reversed. In abreaction, patients frequently exhibit alternate laughing and crying, indicating autonomic fluctuations; these behaviors are sometimes also observed in trance or meditation. Of greatest import, however, is Gellhorn's contention that during abreaction oscillations in ergotropic-trophotropic functioning often lead to a "new setting of the level of autonomic balance," a hysteretic change described as "relatively long-lasting" (Gellhorn and Loofbourrow, 1963:297). In other words, abreaction helps the individual to reexperience, under controlled conditions, intense emotional responses to stress-provoking stimuli, permitting discharge of affect with accompanying physiological readjustments. The heightened tensions excite the ergotropic system to the extent that trophotropic rebound results, establishing a new configuration of internal functioning (Gellhorn and Kiely, 1973:256). Sargant (1957, 1974), although focusing on the impact of abreaction on excitation of the cerebral cortex, contends that faith healing and mystical experiences are products of physiological processes that occur when there is a neural "spillover" of impulses; in his view religious conversion and ritual trance are clearly forms of abreaction, although employed in sacred contexts.

Employing similar neurophysiological principles, implosion therapy, by bombarding the patient with sustained fear-evoking stimuli, initially elicits strong ergotropic excitation, and, ultimately, the emotional "flooding" so exhausts the person that trophotropic rebound occurs (Gellhorn and Loofbourrow, 1963:225). However, the closest secular analogue to ritual can be found in group-interaction therapies. For these techniques Gellhorn and Kiely note the efficacy of "systematically practicing and modifying

expressive movements such as posture, gesture, speech, and singing" in altering disturbed behavior patterns, citing the work of Born (1953).

In group-interaction therapies feedback from proprioceptors, as in singing and dancing, seems to evoke new patterns of affective response in the hypothalamus, limbic system, and neocortex (Gellhorn and Kiely, 1973:257). Instead of employing

> anxiety-provoking stimuli, action therapies avoid primary emphasis on perceptual, cognitive, and affective experience and address themselves to overt, objectively observable behavioral changes. They assume that changes in thinking and feeling may best be effected by modifying the way one acts, rather than the reverse. The physiological experiments demonstrating the effect of proprioceptive impulses on hypothalamic activity and upon the T-E balance support this interpretation (1973:256).

This form of therapy provides important clues for an assessment of the neurophysiological changes that occur in ritual trance.

In rituals, symbolic content, although certainly present, is highly standardized, designed to evoke similar emotional responses in all participants. More importantly, for individual or group variations in interpretations of symbols appear inevitable (Chapple, 1970:314–317), behavior is also fixed. To excite the appropriate neurophysiological centers—and thus rest trophotropic-ergotropic balance—the performance or a ritual requires strict adherence to patterned posture, gesture, speech, and (perhaps) singing modes that are traditionally sanctioned rather than innovative.

The absence of extreme stress, characteristic of both abreaction and implosion therapies, also points to the similarity of rituals to group-interaction therapies. Although attention to performance increases awareness of interactive cues (Chapple, 1970:317), strong anxiety could produce mixed neural discharges in inappropriate centers, resulting in dysphasia. The disruptive power of anxiety also explains the reluctance to change rituals and the general conservative tendency of primitive society, with its strong emphasis on ritual drama, [features detailed by Diamond (1974:137–138; 150–159)] for individualistic alterations in ritual would be likely to lead to greater stress—and under acute stress organisms are less able to learn and to adapt with new behaviors.

Moreover, the very term *life crisis* conjures a picture of a threatened, ergotropically tuned individual or group in need of nurturance, and nurturant behavior elicits trophotropic response. To establish equilibria, standardized mobilization of all or significant numbers of persons must take place. As Chapple observes:

> In rites of passage, and, in a less obvious and dramatic sense, in rites of intensification, performance of the rites, in almost every society, is obligatory. Not only must everyone be present, but one is required to carry out the interaction forms . . . whatever their idiosyncratic tendencies, the participants must carry out the interaction forms even if, as often has been observed, they have to be dragged through the motions by others (1970:317)

If the ritual is conducted correctly, the result is easing of tension or strain (*Ibid.*). Significantly, another relevant aspect of ritual is the shift to the mode of consciousness characteristic of the right cerebral hemisphere, associated, according to Ornstein (1972:178), with perceptions of unity and holism. Hence, individuals, eager or reluctant, are integrated into a group, not only by the sharing of pleasurable emotions through participation in formalized, repetitive, precisely performed interaction forms, but also by a mode of thought that reinforces feelings of solidarity.

Conclusion

The *raison d'être* for rituals is the readjustment of dysphasic biological and social rhythms by manipulation of neurophysiological structures under controlled conditions. Rituals properly executed promote a feeling of well-being and relief, not only because prolonged or intense stresses are alleviated, but also because the driving techniques employed in rituals are designed to sensitize or "tune" the nervous system and thereby lessen inhibition of the right hemisphere and permit temporary right-hemisphere dominance, as well as mixed trophotropic-ergotropic excitation, to achieve synchronization of cortical rhythms in both hemispheres and evoke trophotropic rebound.

Furthermore, it is difficult to separate the impact of repetitive behaviors on the brain from their influence on the rest of the nervous system because the various driving techniques simultaneously excite numerous neural centers. In a given ritual one specific practice alone may be sufficient to establish a state of trance; that several techniques are engaged concomitantly or sequentially indicates redundancy, to guarantee reliability, potentially affecting the entire group of participants. In other words, manifold driving techniques accommodate individual differences in experience and genetic makeup. However, any complete interpretation of ritual trance also recognizes the symbolic qualities of human behavior, since other biologically based activities, such as eating, sleeping, and reproduction, are not confined to mere satisfaction of biological necessities but are also embellished with other behaviors.

Driving practices, whether involving ingestion or exposure to substances that alter the body's biochemical milieu, manipulation of neural reflexes, or symbol systems, function as follows:

> 1. by either blocking sequential information processing of the left hemisphere via bombardment of repetitive stimuli and thus holding activity in that hemisphere constant or by providing stimuli that the right hemisphere is especially suited to process, or both;
> 2. by promoting trophotropic dominance, often through direct stimulation of the PNS, or intense activation of the ergotropic system to elicit trophotropic rebound, or both;
> 3. by lessening motor activity and thus facilitating trophotropic dominance through relaxation of the skeletal muscles or by increasing motor activity, resulting in ergotropic excitation to the extent that trophotropic rebound eventually results.

Various combinations of these procedures characterize ritual trance, but until systematic investigations of autonomic balance are done in geographically distant populations, one can only speculate that the adoption of particular driving techniques is at least partially derived from genetically based autonomic factors.

The impact of different life-styles on unknown configurations of autonomic balance is even more obscured by lack of data and therefore merits extensive cross-disciplinary research.

In summary, although concrete empirical data from neurobiological studies of ritual trance incorporating extensive body motion are unavailable, one can extrapolate from general principles of neurophysiological function and the limited observations of sedentary ritual trance that neuroscientists have reported. Several working hypotheses derive from the foregoing discussion:

1. Each individual has a characteristic trophotropic-ergotropic balance, acquired from genetic inheritance and influenced by experience.
2. Life circumstances, including conflict, disturb this balance, resulting in ergotropic tuning, and in extreme cases, trophotropic rebound or mixed discharges.
3. Dysphasias in trophotropic-ergotropic balance generate maladaptive behavior.
4. Alleviation of dysphasic neurobiologic function is necessary for the conduct of concerted actions and the reduction of conflict within a group.
5. Seeking homeostasis, rituals entrain or synchronize biological rhythms, establishing equilibria.
6. In rituals, as in other forms of therapy, interaction patterns counter dysphasias by the use of tuning.
7. Tuning requires intense or sustained excitation of the ergotropic-trophotropic system, and hence driving techniques augment neurophysiological responses.
8. Driving techniques facilitate right-hemisphere dominance, resulting in gestalt, timeless, nonverbal experiences, differentiated and unique when compared with left-hemisphere functioning or hemisphere alternation.
9. Rebound in the trophotropic-ergotropic system, which results from tuning via driving techniques, shifts balance in the trophotropic-ergotropic system toward life-conserving trophotropic function via exhaustion.
10. Rebound from tuning establishes a new balance; new patterns of right-left hemisphere integration can also result.

This analysis, although admittedly preliminary, points to the need for further research, on the part of anthropologists as well as neuroscientists, to refute, support, or revise evidence provided by the author. Although the opinion has often been advanced that ritual trance behaviors are not amenable to holistic study in laboratory contexts, this belief retards thorough, systematic research characteristic of scientific investigation that can eventually illuminate the neurophysiological bases of trance.

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